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## A Comparison of Athletes and Non-Atheletes at the Univeristy of North Dakota as Measured by the Harvard Strep Test

Michaela L. Gaddie

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A COMPARISON OF ATHLETES AND NON-ATHLETES  
AT THE UNIVERSITY OF NORTH DAKOTA  
AS MEASURED BY THE HARVARD STEP TEST

The writer gratefully acknowledges his indebtedness  
to Dr. Henry A. Lamm, Supervisor of Graduate Students at the  
University of North Dakota for his advice and guidance in the  
preparation of this research paper.

by

Michael L. Gaddie

He further wishes to express his gratitude to all  
those who so kindly responded to the statistics  
and information for this study.

A Research Study  
Submitted to the Faculty  
of the  
Graduate School  
of the  
University of North Dakota  
in partial fulfillment of the requirements  
for the Degree of  
Master of Education

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should appeal to every normal young man. It is well known that a satisfactory degree of physical fitness cannot be maintained if training is stopped.

Studies conducted at Harvard University have shown that physical condition for hard muscular work can be measured only if certain physiological reactions of the subject to hard work are known. Reactions to moderate work are unreliable because the easier the work, the less clear cut are the differences between the fit and the unfit.

"A satisfactory estimate of a man's condition can be obtained by exposing him to a standard exercise that no one can perform at a steady rate for more than a few minutes."<sup>1</sup> This exercise must not require unusual skill. Furthermore, the exercise must place the cardiovascular system under real

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<sup>1</sup>Lucien Brouha, "The Step Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men," Research Quarterly Vol. XIV, (March, 1943), p. 31.

stress by involving large muscle groups. In order to meet these two requirements the Harvard Step Test was used in conducting the following study.

## CHAPTER I

### INTRODUCTION

Physical Educators for a number of years have had considerable interest in the physical condition of the American population, the ability of this population to perform hard work in an efficient manner and recover from this same hard work. To become physically fit is an aim that should appeal to every normal young man. It is well known that a satisfactory degree of physical fitness cannot be maintained if training is stopped.

Studies conducted at Harvard University have shown that physical condition for hard muscular work can be measured only if certain physiological reactions of the subject to hard work are known. Reactions to moderate work are unreliable because the easier the work, the less clear cut are the differences between the fit and the unfit.

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stress by involving large muscle groups. In order to meet these two requirements the Harvard Step Test was used in conducting the following study.

### The Problem

The main problem of this study was to compare the differences in physical condition between athletes and non-athletes, at the University of North Dakota.

In the past, there has been some controversy over the importance of physical condition in relation to athletes. It is hoped that this study has added some specific information which might be used in solving this problem. However, the writer realizes that condition is but one of the many factors that affect the ability of an athlete.

The specific purposes of the study were:

1. To make a comparison of the mean scores of athletes and non-athletes, as measured by the Harvard Step Test.
2. To compare the amount of time completed on the Harvard Step Test by athletes and non-athletes.
3. To compare the mean scores of the athletes of various sports as measured by the Harvard Step Test.
4. To compare the mean scores of non-athletes participating in the intramural program with non-athletes engaged in little or no exercise.
5. To determine whether or not the factor of height may influence the results of the Harvard Step Test.

### Need for the Study

In recent years, educators in many fields have made attempts to decrease interscholastic competition and eliminate the physical education requirement at the college level. Many would like to see physical education non-existent at the college level while others favor a physical education program conducted on a voluntary basis. This voluntary idea presented by many educators is not sound for the following reason. If colleges had physical education on a voluntary basis, only students interested would enroll and not those that need the physical activity offered.

The writer felt there was a definite need to present evidence that interscholastic competition and physical education must remain in the educational program if the United States is to achieve the goal of becoming a well-adjusted nation. For this reason, it is apparent there is a need for such a study on the college level.

### Delimitations

This problem was limited to college men at the University of North Dakota. The group which took the test ranged from eighteen to twenty-eight years of age. The test was administered during the months of April and May. Athletes from basketball, football, baseball, track, hockey, and wrestling teams were tested during the month of May. The non-athlete group were seniors enrolled in the colleges of Education, Engineering, Science, Literature and Arts and Business Administration.



### Definitions

Athlete: An individual participating in one or more of the following varsity sports: basketball, baseball, football, hockey, track and wrestling.

Non-athlete: An individual not participating in any varsity sport and enrolled as a senior at the University of North Dakota.

Harvard Step Test: A test to determine physical condition, the ability of an individual to perform hard work in an efficient manner and recover from this same hard work. The test consists of having a subject step up and down a twenty inch bench thirty times a minute for five minutes, unless he stops from exhaustion before the five minutes expire. The score is obtained by dividing the duration of exercise by the sum of pulses in recovery according to the formula.

$$\text{Index} = \frac{\text{Duration of exercise in seconds} \times 100}{2 \times \text{sum of pulse counts in recovery}}$$

1. 30 per cent were in poor physical condition.

2. 33 per cent were in fair physical condition.

3. 24 per cent were in good physical condition.

4. 11 per cent were in excellent physical condition.

The majority of the last group were varsity and junior varsity athletes.

During this same period the test was administered to 125 qualified college athletes. At the time of their examination not all of these men were in full training but all were physically active. The average score for the athletes was 95, none scoring under 70; 37 per cent were in good physical condition and more than half, or 54 per cent, were

in excellent physical condition scoring better than 90 per cent. Comparable results obtained with the 1943 samples for various types of athletic activities follow.

## CHAPTER II

ACTIVITY	NUMBER	AVG. INDEX	SCORE RANGE
Baseball	27	90	79-101
Track Varsity	33	88	75-108
Track Fresh	8	88	74-117
Crew Varsity	8	100	92-100

### REVIEW OF LITERATURE

In a study conducted by Lucian Brouha to find the fitness of the college population in Harvard College, the Harvard Step Test was given to 2,167 students regardless of their training condition or of their participation in athletics, intramural sports, or the conditioning program. Thus, the group was representative of the college population as a whole and included men of low physical efficiency who were in the "Special Exercise" class as well as varsity athletes who were in full condition. The results of this test follows:

1. 10 per cent were in poor physical condition.
2. 55 per cent were in average physical condition.
3. 24 per cent were in good physical condition.
4. 11 per cent were in excellent physical condition.

The majority of the last group were varsity and junior varsity athletes.

During this same period the test was administered to 125 qualified college athletes. At the time of their examination not all of these men were in full training but all were physically active. The average score for the athletes was 93, none scoring under 70; 37 per cent were in good physical condition and more than half, or 54 per cent, were

in excellent physical condition scoring better than 90 per cent. Comparable results obtained with the 1943 athletes for various types of athletic activities follow.<sup>2</sup>

ACTIVITY	NUMBER	AVG. INDEX	SCORE RANGE
Baseball	23	90	79-103
Track Varsity	22	95	75-108
Track Frosh	41	88	76-113
Crew Varsity	8	109	92-129
Crew Frosh	8	85	76-96

In 1948, Edwin R. Elbel reported the relationship between Pre-Exercise and Post-Exercise Pulse Rate.

From the results of the data, Elbel drew the following conclusions:

Fifty male university students presumed to be in good physical condition performed the step-up exercise during three different periods of activity as follows:

1. For thirty seconds at a rate of eighteen steps per minute.

2. For sixty seconds at a rate of eighteen steps per minute.

3. For four sixty second bouts of exercise at the rate of thirty-six steps per minute.

The data for pre-exercise rates were compared with those for the rates following exercise. Data for increase in pulse rate due to exercise were also correlated with the body weight. It was determined that:

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<sup>2</sup>Lucien Brouha, Norman W. Fradd, and Beatrice M. Savage, "Studies in Physical Efficiency of College Students," Research Quarterly (October, 1943), p. 211.

1. The coefficient of correlation between body weight and increased pulse rate due to exercise is insignificant.

2. Considering the three groups classified according to pre-exercise pulse rate, it was found that there is not a true difference between the mean pulse increase for groups following mild and moderate exercise.

3. Following strenuous exercise there is a true difference between the mean increase for the group with low and the group with rapid pre-exercise pulse rates.<sup>3</sup>

In a study involving 75 healthy young men, of whom 51 were medical students and 24 were students of physical education, E. N. Keen and A. W. Sloan from the Departments of Anatomy and Physiology, University of Cape Town, Cape Town, South Africa received the following results from the Harvard Step Test.

Their interest was, influence of stature and leg length on the ease with which subjects mount a step of considerable height. It appeared as though the tall, long legged students would have less difficulty than the shorter fellows.

1. Five medical students were excluded from the series because they were unable to keep proper time or because they paused during the test.

2. By a strange coincidence the mean stature and leg length in the two groups were the same.

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<sup>3</sup>Edwin R. Elbel, "The Relationship Between Pre-Exercise and Post-Exercise Pulse Rate," Research Quarterly, Vol. XIX, (October, 1948), pp. 222-227.

3. Stature, weight, leg length showed no correlation with the results of the step test in either group or the series as a whole.

4. Twenty-two medical students failed to complete the five minute exercise.

5. All students in physical education completed this five minute period of exercise.

6. Even excluding those medical students who failed to complete the test, the physical education students still had a much higher score than the remaining medical students, the difference being highly significant (Means 85.6 to 73.5).

7. Physical education students had a lower pulse rate increase from the exercise than did the medical students (Means 44.5 to 51.7).

Finally, the value of the test as an indication of physical fitness for strenuous exertion is shown by the much better performance of the physical education students than the medical students. The physical education students were all undergoing systematic physical training and it is reasonable to assume that they were fitter than the medical students and that the difference in fitness of the two groups shown by the test was a real difference in capacity for strenuous physical exertion.

The results of this study fail to justify any lowering of the step for shorter adult men.<sup>4</sup>

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<sup>4</sup>E. N. Keen and A. W. Sloan, "Observations on The Harvard Step Test," Journal of Applied Physiology (September, 1958), pp. 241-243.

Carl C. Seltzer conducted a study on Anthropometric Characteristics and Physical Fitness to determine:

1. The extent of the relation of a few pertinent anthropometric measures with dynamic physical fitness.
2. The question of the necessity for making correction for variations in stature and leg length.

The data on which this study is based was derived from a group of somewhat more than 300 aviation cadets at a military training center in 1943, and from several groups of college students, principally freshmen at Harvard College.

From the results of the data, Seltzer drew the following conclusions:

1. There was a virtual absence of relation between stature, weight, chest circumference, lower extremity length and lower leg length with physical fitness indices derived from the step test in a group of aviation cadets before and after a severe physical training period.
2. Before training, the extremely short individuals show a slight tendency to have rather low physical fitness indices.
3. Individuals with low physical fitness indices tend more frequently to be above the mean in body weight.
4. When individuals attain a state of physical efficiency, the correlations with the anthropometric characteristics become even smaller or disappear entirely.
5. The data indicate that those individuals who are stocky, and thick-set in body build tend to have low physical

fitness indices before training. After reaching a state of physical condition, the thick-set individuals approach the level of efficiency of the linear individuals.

6. All the present data indicate that on the average there is a low degree of correlation of association between body-build forms and the physical fitness index.

7. From the data presented there is no evidence of any appreciable advantage in physical fitness scores of the tall, long-legged individuals over the short-stature, short legged persons.<sup>5</sup>

Another study that is related was made by Dominick A. Taddonio. The purpose of the study was to determine:

1. The relation of training in running to the Harvard Step Test Score.
2. The relationship of the Harvard Step Test to the order in which subjects finished the marathon and cross-country races.

Five groups of subjects, all males, were used in this study. All of them, except marathon runners, were college students.

1. Marathon runners, trained for distances of over ten miles.
2. Varsity cross-country runners, trained for distances of four or five miles.

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<sup>5</sup>Carl C. Seltzer, "Anthropometric Characteristics and Physical Fitness," Research Quarterly, Vol. XVII, (March, 1946), pp. 10-20.

3. Freshman cross-country, trained for two and a quarter to three and a quarter miles.

4. Sprinters and hurdlers, trained for distances not over 220 yards.

5. Sedentary individuals, taking part only in class physical activities not more than three times a week.

The conclusions of the study are as follows:

1. The Harvard Step Test Score is affected by training in distance running such as marathon and cross-country. The 104 tested subjects ranked according to their mean scores as follows:

a. Sedentary . . . . .	62.45
b. Sprinters and Hurdlers . . . . .	86.45
c. Marathon runners . . . . .	98.58
d. Frosh cross-country . . . . .	105.28
e. Varsity cross-country . . . . .	111.05

2. Since in marathon running the elevation of the feet is reduced to a minimum, marathon runners experienced discomfort in doing the Harvard Step Test and have a lower score than cross-country men, whose training requires a higher elevation of the legs.

<sup>6</sup>Dominick A. Taddonio and Peter V. Karpovich, "The Harvard Step Test as a Measure of Endurance in Running," Research Quarterly, Vol. XXII, (October, 1951), pp. 381-384.

1. A bench 20 inches high, 12 inches wide, and 36 inches long
2. Electric Step Clock.
3. Electric Metronome.
4. Sphygmoscope.

Appendix A.

<sup>7</sup>Luoten Krohn and J. Roosevelt Gallagher, "A Simple Method of Testing the Physical Fitness of Boys," Research Quarterly, Vol. XIV, (March, 1943), p. 25.



### CHAPTER III

#### METHOD OF PROCEDURE

College students of the University of North Dakota were used in this study. The Harvard Step Test was administered to fifty athletes and fifty non-athletes. Preliminary to the first test each subject was given a uniform set of instructions.<sup>7</sup> Before being tested each subject rested for approximately five minutes. It should be emphasized that only the heart rates during the recovery period following exercise need be determined. The initial heart rate before exercise is started was not taken and, furthermore, is not important. "Research has shown that the initial heart rate of healthy young men does not have a significant relationship to an individual's physical fitness; his fitness depends on the rate at which his heart slows after exercise and not on how fast it may have been beating before he began to work."<sup>8</sup>

#### Detailed Instructions For The Harvard Step Test

##### Equipment

1. A bench 20 inches high, 12 inches wide, and 16 inches long
2. Electric Stop Clock.
3. Electric Metronome.
4. Stethoscope.

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<sup>7</sup>Appendix A.

<sup>8</sup>Lucien Brouha and J. Rosewell Gallagher, "A Simple Method of Testing the Physical Fitness of Boys," Research Quarterly, Vol. XIV, (March, 1943), p. 25.

Procedure

All subjects were tested by the writer. Each subject stood at attention in front of the bench. At the signal "up" the subject placed one foot on the bench, then stepped up placing both feet fully on the bench, straightened his legs and back and immediately stepped down again one foot at a time. The cadence was set by a metronome at the rate of 180 paces per minute. With the metronome set at this rate, the subject was stepping up and down the twenty inch bench thirty times a minute. The exercise was continued for five minutes unless the subject stopped from exhaustion before the five minutes expired. The duration of the exercise was recorded on the subjects card.<sup>9</sup> The observer made sure that the subject stepped fully on the platform and took a standing position at each step up. No crouching was allowed. The subject had to keep the pace accurately and if he fell behind because he was tired, the observer stopped him after he was unable to keep pace for ten or fifteen seconds.

When the subject stopped, he immediately sat down. The duration of the exercise was recorded. The observer then recorded the pulse from one to one and one-half, two to two and one-half, and three to three and one-half minutes after the subject stopped working. The actual number of heart beats during each thirty second period was recorded. The pulse was counted with the aid of a stethoscope.

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<sup>9</sup>Appendix B.

### The Calculation of The Score

The three one-half minute pulse counts were added and the sum was multiplied by two. The duration of the exercise in seconds times one hundred was then divided by the sum of the pulse rates, and the result was the Physical Fitness Index (PFI). The athletes and non-athletes were then classified according to the following standards.

Below 55 = Poor Physical Condition  
 55-64 = Low Average Physical Condition  
 65-79 = High Average Physical Condition  
 80-89 = Good Physical Condition  
 Above 90 = Excellent Physical Condition

In order to simplify the calculation, a table was used which gave directly the scores for all those who finished the five minute step test.<sup>10</sup> After totalling the actual number of heart beats counted during the three thirty second periods, the score was read directly from the table.

The results obtained were then used in Chapter four to compare the athletes and non-athletes.

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High Average	65-79	9	13
Low Average	55-64	0	4
Poor	55-below	0	27

---

In TABLE 1, fourteen athletes were considered in excellent condition as measured by the Harvard Step Test in comparison to one in excellent condition from the non-athletic group. It should be pointed out that this one non-athlete with the excellent condition score has been participating in a

physical education class every semester since enrolling at the University four years ago.

Twenty-seven athletes were considered in good physical condition, seven of the excellent scoring range

CHAPTER IV

ANALYSIS OF DATA

According to the standards devised at Harvard College for the scoring of the Harvard Step Test, University of North Dakota athletes and non-athletes scored as shown in Table 1.

TABLE 1

PHYSICAL CONDITION SCORES OF ATHLETES AND NON-ATHLETES

Physical Condition	Range of Scores	Athletes	Non-athletes
Excellent	90-above	14	1
Good	80-89	27	5
High Average	65-79	9	13
Low Average	56-64	0	4
Poor	55-below	0	27

In TABLE 1, fourteen athletes were considered in excellent condition as measured by the Harvard Step Test in comparison to one in excellent condition from the non-athletic group. It should be pointed out that this one non-athlete with the excellent condition score has been participating in a

physical education class every semester since enrolling at the University four years ago.

Twenty-seven athletes were considered in good physical condition, seven of these missed the excellent scoring range of ninety and above by one point, scoring eighty-nine. Five non-athletes scored in the good physical condition range, the majority of these students were very active in the intramural program at the University.

Nine athletes finished the step test with high-average condition scores. Of these nine, six were not too active in their varsity sport because of heavy academic loads. Thirteen non-athletes were in high average condition, the majority of which completed the test and were participating strongly in the intramural program.

No athletes were found in the low-average or poor physical condition range. Four non-athletes finished in the low-average group and twenty-seven were considered to be in poor physical condition. This was fifty-four per cent of the non-athletes. The majority of the non-athletes who failed to complete the five minute step test were in the poor condition group.

In a comparison of the mean scores of athletes and non-athletes as measured by the Harvard Step Test, the following data was obtained:

1. The mean score of the athlete group was 86.96.
2. The mean score of the non-athlete group was 54.80.

Referring to TABLE 1, page 15, it can be seen that the non-athletes as a group are in poor physical condition as

measured by the Harvard Step Test. The athletes were only lacking three points of being classified in excellent physical condition as a group with the mean score of 86.96. Even excluding those non-athletes who failed to complete the step test, the athletes still had a much higher score than the remaining non-athletes, the difference being quite significant (Means 86.96 to 76.18).

TABLE 2

COMPARISON OF TIME COMPLETED ON THE HARVARD  
STEP TEST BY ATHLETES AND NON-ATHLETES

Time Completed in Seconds	Non-athletes	Athletes
50-99	3	
100-149	10	
150-199	8	
200-249	8	
250-299	4	
300	17	50

All fifty athletes completed the required three hundred seconds on the step test as compared to seventeen for the non-athlete group. Of the seventeen non-athletes completing the step test, fourteen were participating in the intramural program at the University. The thirteen students

completing fifty-one to one-hundred forty-nine seconds on the step test were participating in little or no physical activity.

TABLE 3 shows the difference in mean scores between athletes participating in various sports at the University of North Dakota. It should be understood that a point difference between any two varsity groups does not mean that one is considerably superior to the other in physical condition.

TABLE 3  
COMPARISON OF THE ATHLETES OF THE VARIOUS SPORTS

Sport	Range of Scores	Number Tested	Mean Score
Basketball	85-100	5	91.00
Baseball	71-91	10	81.30
Football	78-101	14	86.50
Hockey	75-114	6	86.50
Track	72-132	12	90.00
Wrestling	90-91	3	90.66

Basketball, wrestling and track athletes had the highest mean scores. Basketball athletes scored the highest on the Harvard Step Test and their sport had been out of season longest. Basketball, wrestling and track athletes were in excellent condition, all scoring ninety or above. As stated earlier, it is impossible to select which of these

three groups is superior to the other two because the differences in scores are not significant.

The only highly significant difference occurred between the three highest groups and the baseball team which had a mean score of 81.30. However, the baseball athletes were classified as being in good condition. The baseball team at the time of the test was operating under the handicap of being unable to work outdoors due to bad weather conditions. Had they been practicing outdoors, the writer feels their mean score would probably have been higher.

In the comparison of Non-athletes participating in the Intramural program with Non-athletes engaged in little or no physical activity, the following results were obtained:

Eighteen non-athletes participated in the intramural program at the University of North Dakota. These students participated in at least one intramural sport. Their range was from a high of ninety-five to a low of twenty-two. The mean score of the intramural group was 62.78. This mean score of 62.78 classified the intramural group as being in low average physical condition.

Thirty-two non-athletes were considered as having little or no physical activity. Those students classified as having a little activity golfed once a week in the summer and bowled occasionally during the winter months. There were also a few who spent several evenings swimming during the summer. Their range was from a high of eighty-one to a low of twenty-two. The mean score of this group was 50.31. The mean score of



50.31 classified them as being in poor physical condition as measured by the Harvard Step Test.

Before the study was conducted, it appeared as though the taller students would score higher than the shorter students taking the Harvard Step Test.

TABLE 4 indicates that height is not a factor in influencing the results of the Harvard Step Test.

The shorter athletes had the highest mean score of 88.91 as compared to 87.83 for the athletes six feet and over. This is not highly significant, but it does indicate that height is not a differentiating factor on the Harvard Step Test. The shorter non-athletes also recorded the highest mean score of 64.50 as compared to 52.25 for the non-athletes six feet and over. A probable reason for the difference being the taller non-athlete tired faster than the shorter non-athlete because of the height he had to raise his legs in order for him to place his feet on the bench.

However, when the athlete and the non-athlete groups were combined, it was found that height does not influence an individual's score on the step test. This is different from earlier research reported on height as a factor in influencing the results of the Harvard Step Test. Seltzer reported that short individuals show a slight tendency to have rather low physical fitness indices.<sup>11</sup>

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<sup>11</sup>Seltzer, loc. cit.

TABLE 4

HEIGHT AS AN INFLUENCE ON THE  
RESULTS OF THE HARVARD STEP TEST

Height	Number of		Mean Score		Combined Group	
	Athletes	Non-athletes	Athletes	Non-athletes	No. Tested	Score
5'6"-5'8"	12	6	88.91	64.50	18	80.77
5'9"-5'11"	20	24	85.00	54.25	44	63.63
6'-over	18	20	87.83	52.25	38	69.26

From the data obtained the following conclusions were drawn:

1. Fourteen athletes or twenty-eight per cent were considered in the excellent condition range as compared to one non-athlete. However, this one non-athlete had been participating in physical education classes since enrolling four years ago at the University of North Dakota. This one case does not indicate that all students participating in physical education classes will be in excellent condition. However, from this single case it can be understood that improvement will be found in an individual's physical condition if he has regularly scheduled physical activity.

2. Twenty-seven athletes finished the step test in good physical condition. Seven of these athletes placed the excellent group by one point with a mean score of eighty-nine. As stated earlier in another chapter, one point does not make one individual superior to another in physical condition.

3. Five non-athletes finished the step test in good physical condition and thirteen non-athletes were classified in high-average physical condition. These were the eighteen students participating in the physical education program. This also indicated that individuals taking part in regularly scheduled physical activity generally score higher on the step test than those who do not.

CHAPTER V

SUMMARY AND CONCLUSIONS

The main problem of this study was to compare the difference in physical condition between athletes and non-athletes at the University of North Dakota, as measured by the Harvard Step Test.

From the data obtained the following conclusions were drawn:

1. Fourteen athletes or twenty-eight per cent were considered in the excellent condition range as compared to one non-athlete. However, this one non-athlete had been participating in physical education class since enrolling four years ago at the University of North Dakota. This one case does not indicate that all students participating in physical education classes will be in excellent condition. However, from this single case it can be understood that improvement will be found in an individual's physical condition if he has regularly scheduled physical activity.

2. Twenty-seven athletes finished the step test in good physical condition. Seven of these athletes missed the excellent group by one point with a mean score of eighty-nine. As stated earlier in another chapter, one point does not make one individual superior to another in physical condition.

3. Five non-athletes finished the step test in good physical condition and thirteen non-athletes were classified in high-average physical condition. These were the eighteen students participating in the intramural program. This also indicates that individuals taking part in regularly scheduled physical activity generally score higher on the step test than those students with little or no physical activity.

4. Twenty-seven non-athletes or fifty-four per cent were found in the poor physical condition range with a mean score below fifty-five. The majority of this group failed to complete the step up test. These are the seniors who will eventually be the leaders of our country, the United States cannot hope for a well-adjusted nation unless its citizens are physically and mentally sound.

5. The mean score for the athlete group was 86.96 compared to 54.80. As a group, the athletes were lacking a mere three points of being considered in excellent physical condition. With a mean score of 54.80, the non-athlete group was considered in poor physical condition.

6. Even excluding those non-athletes failing to complete the step test, the athletes still had a much higher score than the remaining non-athletes, the difference being (Means 86.96 to 77.18).

7. The entire group of athletes completed the five minute step test as compared to seventeen or thirty-four per cent of the non-athlete group. Of the seventeen non-athletes completing the test, fourteen participated in the intramural

program. Again this indicates, if an individual is to remain in minimum physical condition, he must have some regularly scheduled physical activity whether it be a physical education class or participation on an intramural team.

8. The eighteen non-athletes participating in the intramural program had a mean score of 62.78 compared to the mean score of 50.31 for the thirty-two non-athletes with little or no physical activity. The intramural group was lacking two points of being considered in the high average physical condition range. The group with little or no physical activity was in very poor physical condition as measured by the Harvard Step Test. Steps must be taken to include in the intramural program more of our students not engaged in physical education or athletics. As can be seen from this comparison, there would probably be an increase in the student's physical condition.

9. Because of the closeness in mean scores between the various height groups, it was concluded that height was not a factor in influencing the results of the Harvard Step Test in either the athlete or non-athlete group.

The Harvard Step Test can be used in the physical education program in the following ways:

1. As one measure of the physical condition of the students.
2. To determine the progress and needs of students.
3. As a measure of the physical education program effectiveness.

4. As a means for motivating the improvement of the physical condition of students.

Recommendations for Further Study:

1. A comparison of the sophomore physical education students and sophomore engineering students at the University of North Dakota as measured by the Harvard Step Test. A study of this type will determine the difference in physical condition between students participating in regularly scheduled physical activity and students with little or no physical activity.
2. A comparison of sophomore physical education students and first semester freshmen at the University of North Dakota. From this study the effectiveness of the physical education program at the University of North Dakota can be determined.
3. The improvement in physical condition of freshman and sophomore students at the University of North Dakota. If this test is given at the end of the freshman year and again at the end of the sophomore year, it can be determined what the actual rate of improvement in physical condition there is for a period of one year.

After completion of this study, the writer is convinced that poor physical condition exists in the college students of our nation. Educators cannot afford to permit the nation's future leaders to become physically unfit.

Furthermore, rather than eliminating the physical education requirement at the college level as so many universities across the country are attempting to do, we should be increasing these requirements to develop a stronger nation physically as well as mentally.

The subject to be tested stands in front of a platform twenty inches high. An observer stands behind the subject. The subject places one foot on the bench, steps up until both feet are fully on the bench, with the legs straightened and the body erect, and immediately steps down with one foot at a time. The pace is kept by a metronome. The metronome will be set so the subject must step up and down thirty times a minute. Usually the performer looks off with the same foot each time, but may change the procedure two or three times during the test. The exercise is kept up for five minutes continuously unless the subject stops from exhaustion before the end of that time. In any case, the duration of the exercise in seconds is recorded. The subject must keep pace with the metronome. If the subject is unable to keep pace for ten or fifteen seconds, the observer stops the test.

As soon as the subject stops of his own accord, or is stopped by the examiner at the end of five minutes, he sits down. The observer notes the condition of the exercise, and records the pulse from 1 to 1½ minutes, from 2 to 2½ minutes, and 3 to 3½ minutes after the subject has stopped the exercise. The actual number of heart beats during each of these three thirty-second periods is recorded, and the three records are summed. This sum is then multiplied by 2. The score is obtained by multiplying the duration of the exercise in seconds by 100, and by dividing this result by twice the sum of the heart beats.

Subjects will then be placed in groups as follows:

<u>SCORE</u>	<u>CLASSIFICATION</u>
25 or below	Poor Physical Condition
26-34	Low Average Physical Condition
35-40	High Average Physical Condition
41-47	Good Condition
48 or above	Excellent Condition

## APPENDIX A

### THE HARVARD STEP TEST

This test measures the general capacity of the body to adapt itself to hard work and to recover from what it has done. The results of this test will be used to determine the difference between athletes and non-athletes in general physical condition. Comparisons will also be made to determine the physical condition of players participating in different sports at the University of North Dakota.

#### PROCEDURE

The subject to be tested stands in front of a platform twenty inches high. An observer stands behind the subject. The subject places one foot on the bench, steps up until both feet are fully on the bench, with the legs straightened and the body erect, and immediately steps down again one foot at a time. The pace is kept by a metronome. The metronome will be set so the subject must step up and down thirty times a minute. Usually the performer leads off with the same foot each time, but may change the procedure two or three times during the test. The exercise is kept up for five minutes continuously unless the subject stops from exhaustion before the end of that time. In any case, the duration of the exercise in seconds is recorded. The subject must keep pace with the metronome. If the subject is unable to keep pace for ten or fifteen seconds, the observer stops him.

As soon as the subject stops of his own accord, or is stopped by the examiner at the end of five minutes, he sits down. The observer notes the duration of the exercise, and records the pulse from 1 to 1½ minutes, from 2 to 2½ minutes, and 3 to 3½ minutes after the subject has stopped the exercise. The actual number of heart beats during each of these three thirty-second periods is recorded, and the three records are summed. This sum is then multiplied by 2. The score is obtained by multiplying the duration of the exercise in seconds by 100, and by dividing this result by twice the sum of the heart beats.

Subjects will then be placed in groups as follows.

<u>SCORE</u>	<u>CLASSIFICATION</u>
55 or below	Poor Physical Condition
56-64	Low Average Physical Condition
65-79	High Average Physical Condition
80-89	Good Condition
90 or above	Excellent Condition



APPENDIX B

TABLE OF SCORES

ATHLETES

Name \_\_\_\_\_ Date \_\_\_\_\_  
 Major \_\_\_\_\_ School \_\_\_\_\_  
 (e.g., SLA, Educ.)  
 Minor \_\_\_\_\_  
 Age \_\_\_\_\_ Height \_\_\_\_\_ Weight \_\_\_\_\_ Class \_\_\_\_\_  
 (e.g., Soph.)  
 Sports \_\_\_\_\_ Practice Time Per Day \_\_\_\_\_  
 Off-Season Activities \_\_\_\_\_  
 Pulse Reading:  
 1st \_\_\_\_\_ 2nd \_\_\_\_\_ 3rd \_\_\_\_\_  
 Number of seconds completed \_\_\_\_\_ Score \_\_\_\_\_

NON-ATHLETES

Name \_\_\_\_\_ Date \_\_\_\_\_  
 Major \_\_\_\_\_ School \_\_\_\_\_  
 (e.g., SLA, Educ.)  
 Minor \_\_\_\_\_  
 Age \_\_\_\_\_ Height \_\_\_\_\_ Weight \_\_\_\_\_ Class \_\_\_\_\_  
 (e.g., Soph.)  
 Activities \_\_\_\_\_ Frequency of Activities \_\_\_\_\_  
 Pulse Reading:  
 1st \_\_\_\_\_ 2nd \_\_\_\_\_ 3rd \_\_\_\_\_  
 Number of seconds completed \_\_\_\_\_ Score \_\_\_\_\_  
 Appointment Time \_\_\_\_\_

APPENDIX C

TABLE OF SCORES

Pulse	Score	Pulse	Score	Pulse	Score
100	150	129	116	172-173	87
101	149	130	115	174-175	86
102	147	131-132	114	176-177	85
103	146	133	113	178-179	84
104	144	134	112	180-181	83
105	143	135	111	182-184	82
106	142	136	110	185-186	81
107	140	137-138	109	187-188	80
108	139	139	108	189-191	79
109	138	140	107	192-193	78
110	136	141-142	106	194-196	77
111	135	143	105	197-198	76
112	134	144	104	199-201	75
113	135	145-146	103	202-204	74
114	132	147	102	205-206	73
115	130	148-149	101	207-209	72
116	129	150	100	210-212	71
117	128	151-152	99	213-215	70
118	127	153	98	216-218	69
119	126	154-155	97	219-222	68
120	125	156-157	96	223-225	67
121	124	158	95	226-229	66
122	123	159-160	94	230-232	65
123	122	161-162	93	233-236	64
124	121	163	92	237-239	63
125	120	164-165	91	240-243	62
126	119	166-167	90	244-247	61
127	118	168-169	89	248-250	60
128	117	170-171	88		

## BIBLIOGRAPHY

### Books

- American Association for Health, Physical Education and Recreation, Research Methods Applied to Health, Physical Education and Recreation. Washington: American Association for Health, Physical Education and Recreation, 1949.
- Good, C. V., Barr, A. S., and Scates, D. E. The Methodology of Educational Research. New York: Appleton-Century Co., 1936.
- McCloy, Charles H. Tests and Measurements in Health and Physical Education. New York: Appleton-Century Co., 1954.
- Turabian, Kate L. A Manual for Writers of Term Papers, Theses and Dissertations. Chicago, Ill.: The University of Chicago Press, 1958.

### Periodicals

- Brouha, Lucien. "A Simple Method of Testing The Physical Fitness of Boys," Research Quarterly, Vol. XIV, (March, 1943), p. 25.
- \_\_\_\_\_. "The Step Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men," Research Quarterly, Vol. XIV, (March, 1943), p. 31.
- \_\_\_\_\_. "Studies in Physical Efficiency of College Students," Research Quarterly, Vol. XIV, (October, 1943), p. 211.
- Elbel, Edwin R. "The Relationship Between Pre-Exercise and Post-Exercise Pulse Rate," Research Quarterly, Vol. XIX, (October, 1948), pp. 222-227.
- Keen, E. N. and Sloan, A. W. "Observations on the Harvard Step Test," Journal of Applied Physiology, (September, 1958), pp. 241-243.

Seltzer, Carl C. "Anthropometric Characteristics and Physical Fitness," Research Quarterly, Vol. XVII, (March, 1946), pp. 10-20.

Taddonio, Dominick A. and Karpovich, Peter V. "The Harvard Step Test as a Measure of Endurance in Running," Research Quarterly, Vol. XXII, (October, 1951), pp. 381-384.